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APPLICATION

FOR

UNITED STATES LETTERS PATENT

TITLE: SEALING ASSEMBLY

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SEALING ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is related to U.S. patent application Ser. No. 10/625,875, filed on July 23, 2003, naming Stefan Tobolka as its inventor. The related application is hereby incorporated by reference.

BACKGROUND OF INVENTION

FIELD OF INVENTION

[0002] This invention relates to an assembly for sealing containers; in particular, it relates to a novel sealing assembly for sealing a web of thermoplastic film or other materials into a series of containers.

DESCRIPTION OF THE RELATED ART

[0003] Sealing machines are used to package fluids, such as granular materials or liquids of various viscosities, from water to syrup in pouches. One type of package or pouch-making machine is a vertical form, fill and seal machine. With vertical form, fill, and seal machines, a heat sealable web material may be supplied from a roll. The flat web material may be unwound and formed into a vertically oriented tube which surrounds a fluid delivery device, such as a spigot. A sealing assembly may be located below the delivery device, sealing across the tube by heat pressing the two layers of web materials together through the use of a moving sealing head reciprocating toward and away from the tube opposite a backstop. Initially, a bottom seal may be made and a quantity of flowable material delivered to the tube. The tube may then be indexed downwardly, and another seal made above the bottom seal so as to form a pouch between the two seals. The second seal will also act as a first seal for the next-to-be formed pouch.

[0004] **FIG. 1** illustrates an exemplary vertical form, fill, and seal machine **100**, in which a flat web **112** of film is unwound from a roll **110** and sealed into a tube **114**

surrounding a spigot **116** by a sealing head **118**. The spigot is used to deliver a fluid to the tube and a sealing assembly **122** may then be used to seal and cut filled pouches **120** from the tube **114**. The filled pouches may be discharged from the machine onto a conveyor belt **130**. The film of the web may be made of a heat sealable flexible, light-weight material, such as a polyethylene/polypropylene laminate or other similar plastic materials.

[0005] The speed of machine **100** may be increased if, rather than metering out a suitable volume of fluid for each pouch before the upper seal to complete the pouch is formed, the tube **114** is filled above the level where the upper seal will be formed. Sealing devices that form a seal through a liquid-containing tube are known in the art. For example, U.S. Patent No. 5,038,550 by Wirsig and Perret, discloses a vertical form, fill and seal machine with a pair of transverse heat sealing jaws, a pair of spreader fingers, and at least a pair of detucker fingers to pinch a longitudinal edge of the tubular film. Another example is the vertical form, fill, and seal device described in U.S. Patent Number 6,164,042 by Tobolka. A drawback with sealing below the fluid level, however, is that if the sealing jaw is reciprocated quickly, it will impart turbulence to the fluid and consequent vibrations to the tube, which can result in an inferior seal being formed. This risks forming pouches that leak.

[0006] Another drawback with known sealing devices is that as the sealing jaws wear down with repeated cycling, the sealing pressure between them reduces. This risks leaking pouches, which when this occurs necessitates re-calibration of the device or replacement of the sealing jaws.

[0007] Therefore, there remains a need for a rapid sealing assembly that will minimize hydraulic turbulence and tube vibration, the occurrence of which may weaken the bond between the layers of the material forming the container, and that will also manage a consistent sealing pressure over many cycles.

SUMMARY OF THE INVENTION

[0008] To seal a tube, such as a tube in a vertical form, fill, and seal machine, the motion profile of sealing jaws is controlled to reduce turbulence of fluid in the tube and

vibration of the tube, thereby promoting a better seal. Additionally, the jaws have an endless stroke so that a consistent sealing pressure may be achieved even after the jaws have worn down with repeated use.

[0009] According to one aspect of this invention, a device for sealing a tube containing a fluid is provided. This device comprises a pair of opposed jaws disposed about the tube, and a motor for driving each one of the opposed jaws toward the other. An indicator, such as a motor rotation indicator, is provided for indicating position of said jaws. A controller is input by the indicator and outputs to the motor for controlling a motion profile of the jaws.

[0010] According to another aspect of this invention, a method for sealing a flexible tube containing a fluid is provided. This method involves driving opposed jaws disposed about a tube toward each other and controlling the speed and rate of speed of said jaws in order to reduce turbulence in the fluid and vibration of the tube as the jaws deform the tube. The jaws are driven into abutment with the tube interposed between the jaws a sealing pressure is applied for a dwell time, and then the jaws are retracted.

[0011] Other features and advantages of the invention will become apparent from a review of the following description in conjunction with the figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] In the figures which disclose example embodiments of the invention:

FIG. 1 is a perspective view of a conventional vertical form, fill and seal machine discharging onto a conveyor belt a succession of sealed pouches.

FIG. 2 is the top view of a sealing assembly made in accordance with an embodiment of the invention.

FIG. 3 is the front view of the sealing assembly of **FIG. 2**.

FIG. 4 is velocity v. time diagram illustrating the velocity profile of a sealing head of the sealing assembly of **FIG. 3**.

FIG. 5 is the top view of an alternative embodiment of a sealing assembly made in accordance with this invention, using a rack and pinion assembly instead of levers to move the sealing heads.

FIG. 6 is an enlarged breakaway view of the rack and pinion assembly of **FIG. 5**.

DETAILED DESCRIPTION

[0013] A sealing assembly is employed to clamp together layers of suitable materials, such as two layers of flexible laminate plastic film and to bond the layers by applying heat and a controlled amount of pressure. In one embodiment of the invention, the sealing assembly includes an upper and lower pair of jaws, each slidably mounted on a pair of parallel shafts, with a mechanism for effecting reciprocal movement of the jaws, together and apart, as required to clamp together the container forming material.

[0014] Referencing the top view in **FIG. 2**, from a home position indicated by a rotary encoder **245**, coupled to motor **250** to track the rotational angle of the motor, the motor **250** turns ball screw **260**. The ball screw **260** is received by a threaded sleeve of a driving element, namely plate **255**. Thus, when the ball screw turns, this moves plate **255** either toward, or away from, stationary frame members **212, 214**. The stationary frame members **212** and **214** anchor the various moving assemblies of reciprocating upper jaws **205** and **215**.

[0015] Upper sealing head (jaw) **205** is bearing mounted on smooth shafts **210** and **220** which are supported by frame members **212, 214** so that the sealing head **205** slides along the shafts **210** and **220** when pushed. Sealing head **205** incorporates an elongate heating ribbon **222** that is heated by a power source (not shown).

[0016] Plate **255** is attached to the upper sealing head **205** through push rods **265** and **275**. A rocker arm **235** is medially pivotably joined to frame **212**. An inboard link arm **270**

is pivotably mounted to the inboard end of the rocker arm and to plate **255**. Movement of plate **255** toward frame **212** pushes the inboard link arm **270** toward frame **212** which, in turn, pushes the inbound end of a rocker arm **235**. The rocker arm **235** is pivotably joined, at its outboard end, to an outbound link arm **230** which is, in turn, pivotably joined to a back support **225**. The back support **225** is fixed to an end of shaft **220**. An identical arrangement of arms **230a, 235a, 270a** links plate **255** to back support **225** at smooth shaft **210**. A backstop (jaw) **215** is fixed to the two smooth shafts **220** and **210** so as to move with the smooth shafts **210** and **220**. Consequently, when plate **255** advances toward frame **212**, pusher arms **265, 275** push sealing head **205** toward the tube **200** and toward backstop **215**. Simultaneously, outbound link arms **230, 230a**, pull the smooth shafts **220, 210**, and therefore the backstop. In consequence, then the sealing head **205** advances toward the backstop, the backstop simultaneously advances toward sealing head **205**. The backstop acts as a back stop for sealing head **205** and may, for example, be fabricated of a high density plastic material.

[0017] Referencing the front view of **FIG. 3**, the mechanism for reciprocating the sealing head and the backstop is repeated with a lower assembly comprising a lower motor **350**, lower ball screw **335**, lower sealing head **305** and lower backstop **315**. Also shown are the rotary encoder **345** of motor **350**, lower plate **355** threaded to lower ball screw **335**, and one of the lower smooth shafts **310**. Fluid delivery spigot **316** is shown here for delivering flowable material into the film tube (which is not shown in **FIG. 3**).

[0018] A processor **370** receives an output from each rotary encoder **245, 345** and outputs to a control input of each motor **250, 350**. The processor is loaded with software from computer readable media **372** which may be for example, a disk, a read only memory, or a file downloaded from a remote source. Additionally, the processor may receive input from a user interface **374** which may be, for example, a keyboard.

[0019] In operation, considering the upper assembly, the advancement of plate **255** toward frame **212** moves the upper sealing head **205** and the upper backstop **215** toward one another to conduct sealing of the tube. Under control of the processor **370**, with input from the rotary encoder **245**, the motor rotates the ball screw **260** through an initial pre-set number of rotations, to advance the sealing head **205** and backstop **215** toward one another.

The motor **250** is then decelerated, possibly to a momentary stop, in which case it is thereafter re-started. Once the motor **250** stalls out, indicating that the sealing head and backstop have been pushed against each other with the tube **200** sandwiched between them, the processor controls the motor voltage to generate a selected torque that provides a selected sealing pressure between the sealing head and backstop.

[0020] The processor may maintain the sealing pressure for a pre-determined dwell time. Thereafter, the motor **250** is reversed to draw the sealing head **205** and backstop **215** away from each other, back to the home position. The encoder **245** has kept a count throughout so that the processor can accurately reposition back to the home position.

[0021] The lower assembly works in exactly the same way. Consequently, both an upper and a lower seal may be applied to the film tube. It will be apparent that the upper and lower sealing assemblies are controlled independently by separate motors with no mechanical connection between the upper and lower sealing assemblies. Because of the independent operation of the upper and lower sealing heads **205** and **305**, the sealing heads **205** and **305** may be co-ordinated in any desirable manner through software control of the processor.

[0022] The processor **370** may control each motor according to a stored motion profile to attain a desirable velocity versus time motion profile for each pair of jaws. For example, where the flowable material is water, the profile illustrated in **FIG. 4** may be used. Considering the lower sealing assembly, the movement of the lower jaws (sealing head **305** and backstop **315**) toward each other can be divided into several phases. In the first phase, the processor controls the motor **350** to progressively accelerate in order to drive the lower jaws, from opposing directions, towards the film at a high rate of speed. This is indicated in **FIG. 4** between roughly 0 ms to 150 ms. When the jaws impact the tube, they impart hydraulic turbulence to the fluid in the tube and vibrations to the tube. To reduce this turbulence and vibration, the motor **350** decelerates in a time window during which tube impact is expected. This window roughly spans 150 ms to 360 ms. The most likely time of impact is 220 ms, in consequence, the motor is decelerated more rapidly prior to 220 ms and more gently after 220 ms. To further reduce this turbulence and vibration, the jaws stop, roughly between 430 ms to 500 ms as shown on the graph of **FIG. 4**, maintaining a gap

between the two layers of film for a fixed period of time. The delay and gap are programmable through the motion controller to suit the liquid being packaged, preparing for the most critical moment when the two layers of film touch and the bonding process begins.

[0023] The motor is then re-started to close the minimal gap between the jaws (between about 500 and 710 ms). As illustrated in **FIG. 4**, at about 710 ms the velocity of the jaws returns to zero as the motor **350** stalls when the jaws move into abutment with each other, with the tube sandwiched between them. At this point, the processor controls the motor's voltage in order to apply a selected torque to the motor. This selected torque is translated by the rotary-to-linear mechanism to result in the application of a selected force between the jaws. This force results in a selected sealing pressure on the film tube along the heated ribbon **222** of sealing head **205**. Once the sealing pressure has been maintained for a desired dwell time (710 to 980 ms), the motor is reversed to return the jaws to a home position (980 to 1190 ms).

[0024] Where the flowable material is more viscous than water, the motion profile may cause the motor to decelerate in the time window of expected impact, but not stop thereafter. Instead, after decelerating during the window of expected impact, the motor may simply continue to advance the heads at a constant, or decelerating, rate, until the motor stalls.

[0025] It is important to recognise that the selected sealing pressure is achieved without the processor having direct information on the distance through which it must advance the jaws so that they abut. Instead, the processor simply keeps advancing the jaws until they do abut. Thus, the jaws have a variable (endless) stroke: they will keep advancing until they abut. This has the advantage that even with the jaws wearing down over repeated cycles of operation, they will still achieve the selected sealing pressure. For example, considering **FIG.4**, it may be that, after a million cycles, the motor will not stall out until 720 ms, due to wear at the face of the jaws. In such instance, the processor will begin to control the motor voltage to achieve the selected sealing pressure at 720 ms, rather than at 710 ms. This result is in contrast to, for example, a sealing assembly having fixed stroke cylinders. In this fixed stroke arrangement, wear on the jaws will result in a reduction of the sealing pressure. This will increase the number of seals that leak. Once the quality of the seals degrades to

unacceptable levels, it would be necessary to take the machine out of service for re-calibration or replacement of the jaws.

[0026] As aforenoted, the motion profile of the jaws reduces hydraulic turbulence before a seal is formed. This helps ensure the tube has a predictable shape when clamped by the jaws. In consequence, the chance of wrinkles at the seal are reduced. Furthermore, reducing the hydraulic turbulence allows the containers to have a precisely consistent volume. Coordinated motion profiles between the upper and lower sealing heads can be modified and stored to the processor to suit a range of tube diameters.

[0027] The heat of sealing may also sever the tube at the bond. Alternatively, a knife associated with the jaws, or a knife below the jaws, may be used. It will be apparent that segments of the tube which have been filled, sealed, and severed form containers, which may be in the nature of pouches.

[0028] **FIGS. 5** and **6** show a different implementation of this invention, using racks and pinions, instead of link arms, to drive the jaws. Turning to **FIGS. 5** and **6**, wherein like parts to those of **FIG. 2** are given like reference numerals, plate **255** of the upper sealing assembly is joined to push rods **565**, **575**. A rack **566** extends from an end of each push rod, which end is joined to the plate **255**. Similarly, a rack **522** extends from the end of each of shafts **510**, **520**, which end is proximate plate **255**. Frame **512** supports two pinions **580**, **590**; each pinion meshes with both a rack **566** of one of the push rods **565** or **575** and a rack **522** of one of the shafts **510** or **520**. In operation, when the motor rotates ball screw **260** so as to advance plate **255** toward frame **512**, the push rods **565**, **575** advance sealing head **205** toward the tube film (not shown) and the backstop **215**. Advancement of the push rods causes the rack of each push rod to rotate the pinion that meshes with it (in a counterclockwise sense). Because each rotating pinion also meshes with a rack **522** of a shaft **510**, **520**, the pinion pulls each shaft **510**, **520**. Since backstop **215** is joined to shafts **510**, **520**, the result is that the backstop is pulled toward the tube and sealing head **205**.

[0029] As an alternative to a rotary encoder, a position sensor may be used to sense the position of one of the linearly moving parts, such as the push rods. In such instance, the processor would learn the motor had stalled when the push rods were not moving despite

the fact that the processor was applying a motivating signal to the motor. As an alternative to a rotary motor and ball screw, a linear motor may be used. In such case, the rotary encoder may be replaced with a motor position sensor or a sensor sensing the position of one of the other linearly moving parts. Obviously, the device could comprise only a single seal sealing assembly rather than the upper and lower sealing assemblies described.

[0030] Other advantages and modifications within the scope of the invention will be apparent to those skilled in the art and, therefore, the invention is defined in the claims.